Announcements

- Homework for tomorrow…

  Ch. 22, CQ 2, Probs. 10, 12, & 14

  CQ3: before

  CQ7: A = 4 cm, λ = 12 m, f = 2.0 Hz

  20.20: a) 3.2×10^{-3} m b) 9.4×10^{10} Hz

  20.24: a) 1.0×10^{10} Hz b) 1.6×10^{-4} s

  20:26: a) 8.6×10^{8} Hz b) 0.23 m

- Office hours…

  MW 10-11 am

  TR 9-10 am

  F 12-1 pm

- Tutorial Learning Center (TLC) hours:

  MTWR 8-6 pm

  F 8-11 am, 2-5 pm

  Su 1-5 pm

Chapter 22

Wave Optics

(The Interference of Light &
The Diffraction Grating)

Last time…

- *Angular position* of m^{th} *bright* fringe…

$$\theta_m = m\frac{\lambda}{d} \quad , \quad m = 0, 1, 2, 3, \ldots$$

- *Position* of m^{th} *bright* fringe…

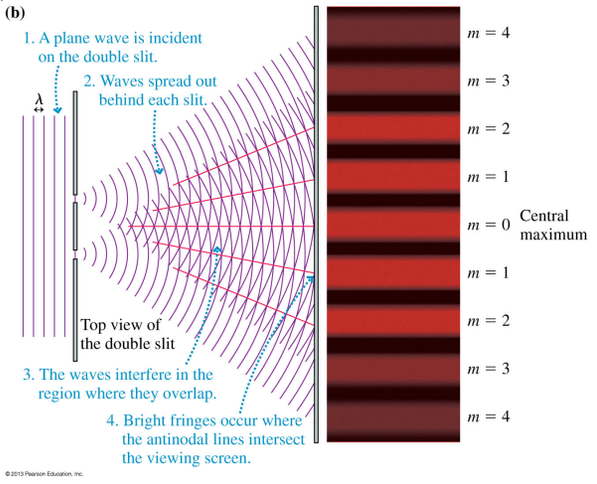
$$y_m = \frac{m\lambda L}{d} \quad , \quad m = 0, 1, 2, 3, \ldots$$

- *Fringe spacing…*

$$\Delta y = \frac{\lambda L}{d}$$

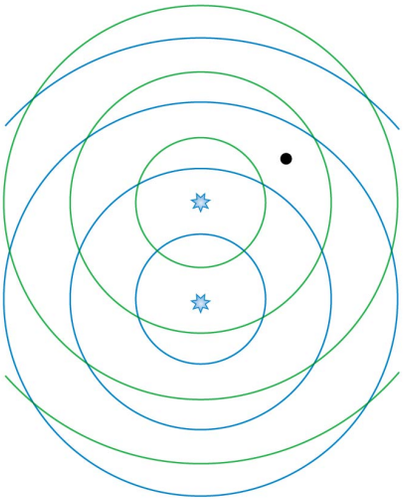
- *Position* of m^{th} *dark* fringe…

$$y'_m = \left(m + \frac{1}{2}\right)\frac{\lambda L}{d}$$



Quiz Question 1

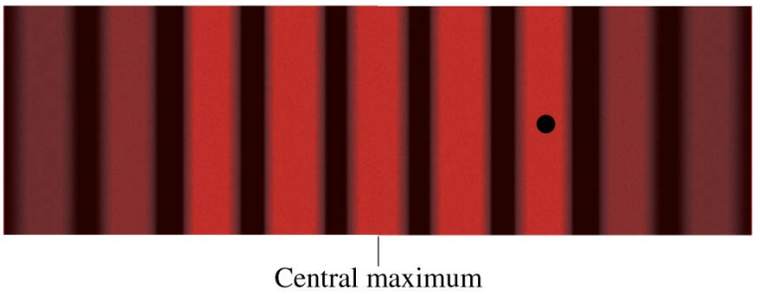
Two rocks are simultaneously dropped into a pond, creating the ripples shown. The lines are the wave crests. As they overlap, the ripples interfere. At the point marked with a dot,



1. The interference is constructive.
2. The interference is destructive.
3. The interference is somewhere between constructive and destructive.
4. There's not enough information to tell about the interference.

Quiz Question 2

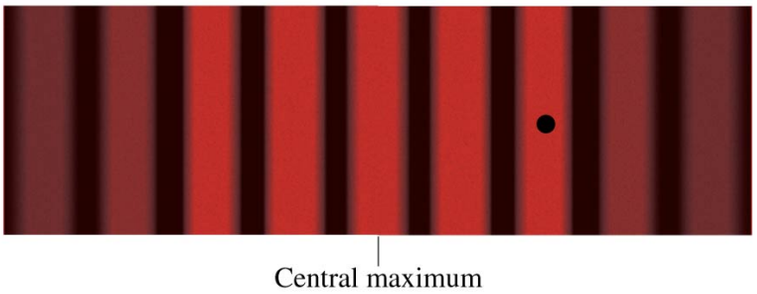
A laboratory experiment produces a double-slit interference pattern on a screen. The point on the screen marked with a dot is how much farther from the left slit than from the right slit?



1. 1.0 λ.
2. 1.5 λ.
3. 2.0 λ.
4. 2.5 λ.
5. 3.0 λ.

Quiz Question 3

A laboratory experiment produces a double-slit interference pattern on a screen. If the screen is moved farther away from the slits, the fringes will be

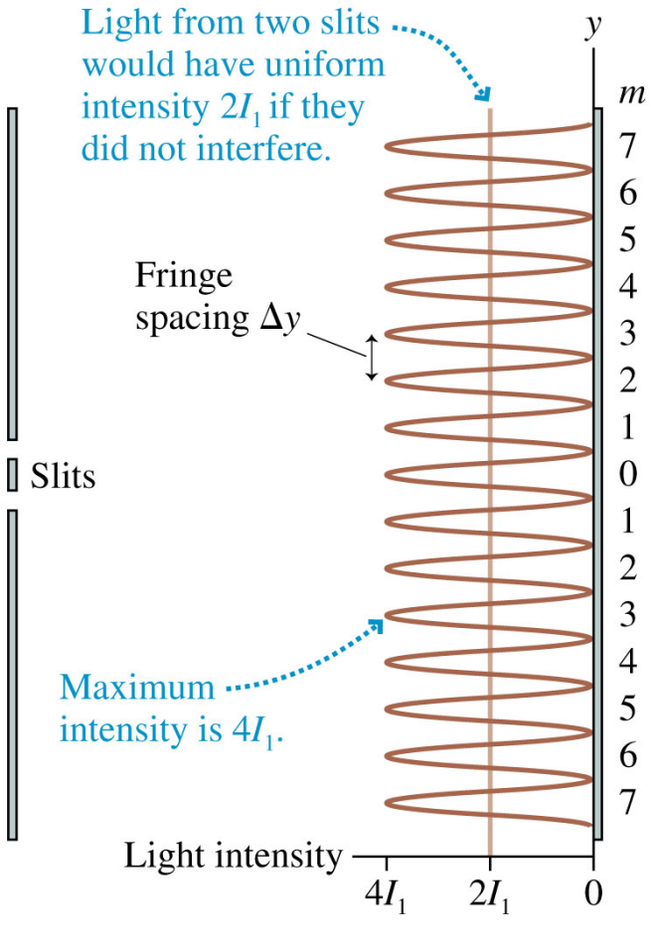


1. closer together.
2. in the same positions.
3. farther apart.
4. fuzzy and out of focus.

Intensity of the Double-Slit Interference Pattern

- *If* there were NO *interference*, the light intensity due to two slits would be *twice* the intensity of one slit ($2I_1$).
- Instead, the superposition of the 2 waves creates *bright* and *dark fringes*.

- What is the *intensity* of the double-slit interference pattern at position y?



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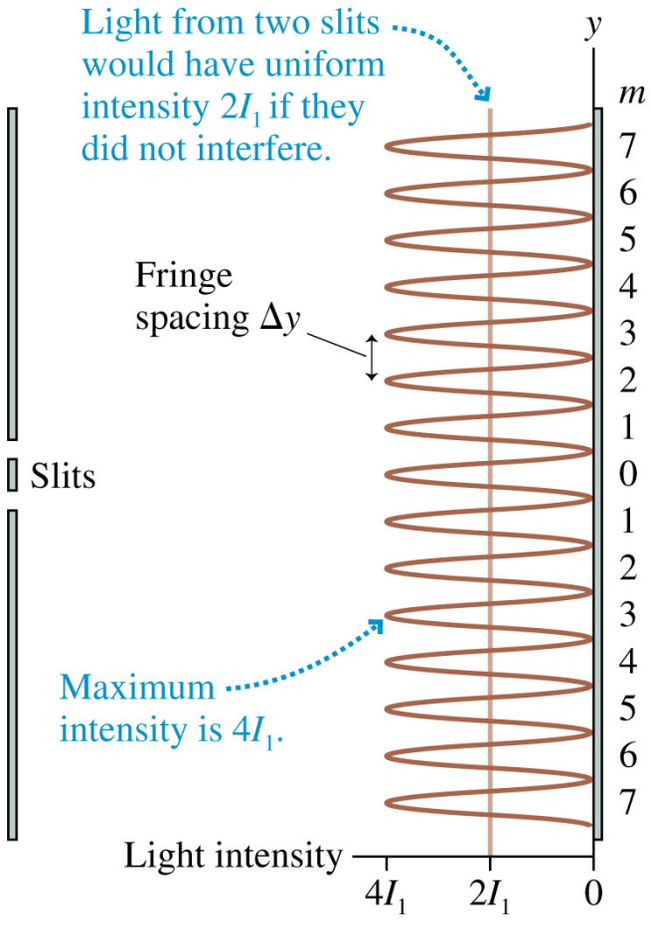
$$I_{double} = 4I_1 \cos^2\left(\frac{\pi d}{\lambda L} y\right)$$

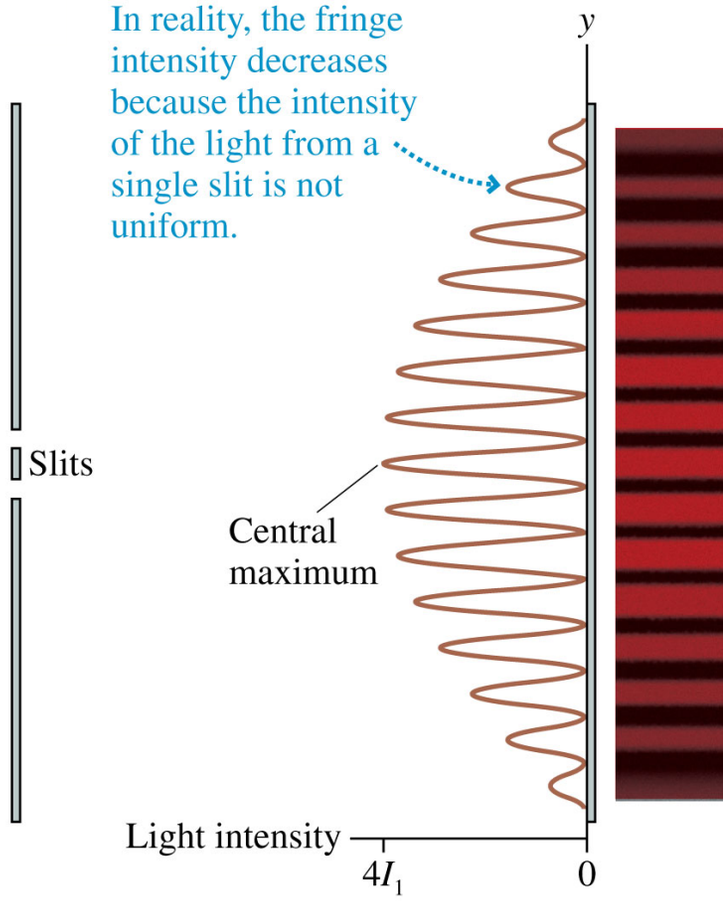
Notice:

Intensity oscillates between 0 and $4I_1$.



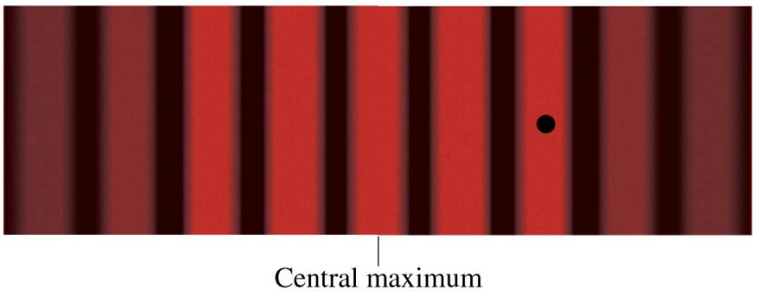
Intensity of the Double-Slit Interference Pattern

The actual intensity from a double-slit experiment slowly *decreases* as $|y|$ *increases*.



Quiz Question 4

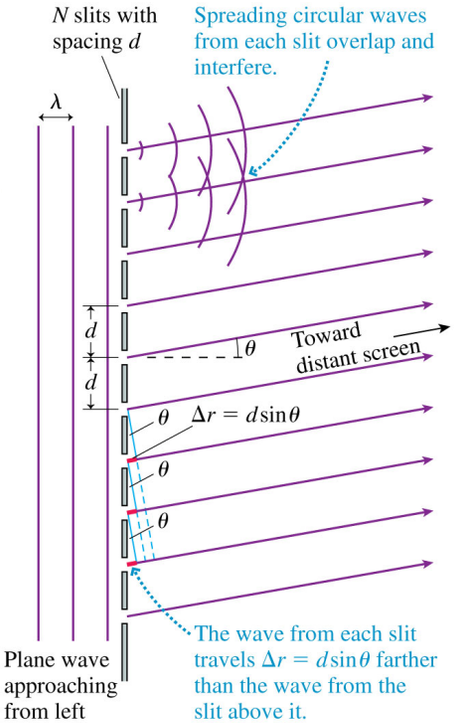
A laboratory experiment produces a double-slit interference pattern on a screen. If the *amplitude* of the light wave is *doubled*, the *intensity* of the central maximum will increase by a factor of



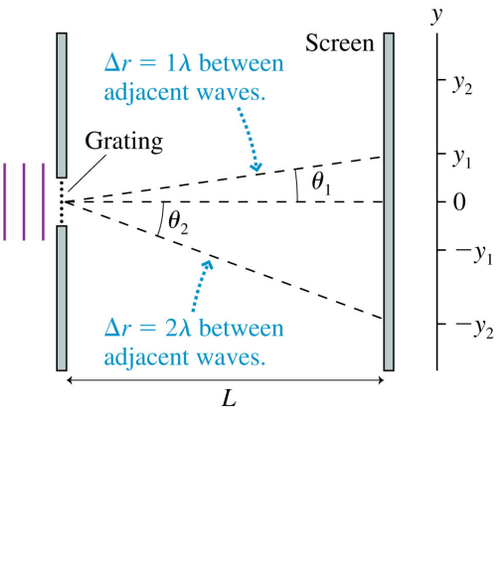
1. √2.
2. 2.
3. 4.
4. 8.

22.3 The Diffraction Grating

- The figure shows a *diffraction grating* in which N slits are equally spaced a distance d apart.
- Only 10 slits are shown here, but a practical grating will have hundreds or thousands of slits.



What are the *angular positions* of the *bright fringes* in the interference pattern?



Where does the m^{th} *bright fringe* occur?

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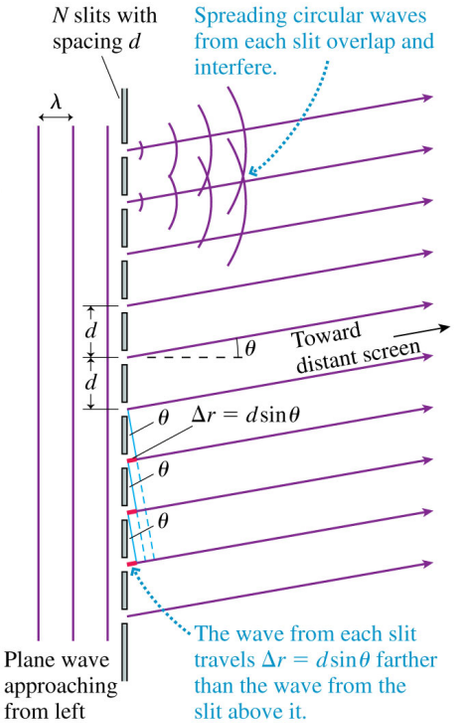

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$$d \sin \theta_m = m\lambda \quad , \quad m = 0, 1, 2, \ldots$$

Where does the m^{th} *bright fringe* occur?

$$y_m = L \tan \theta_m \quad , \quad m = 0, 1, 2, \ldots$$